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XXIII. *A Letter from the Honourable BENJAMIN LINCOLN, Esq; F. A. A. to the Honourable JAMES WARREN, Esq; F. A. A. relating to the ingrafting of Fruit-Trees, and the Growth of Vegetables; inclosing the Observations of his Friend on the Growth of Trees downward after the first Year.*

Hingham, November 3, 1780.

MY DEAR SIR,

I TAKE this early opportunity, agreeable to my promise, to enclose you the sentiments of my friend on grafting, the growth of plants, trees, &c. These were given on a conversation which arose on my mentioning, that I had observed, for a number of years, an apple-tree in my orchard, the natural fruit of which was early, having been grafted with a winter cyon, producing fruit very like in appearance to the fruit produced by the tree whence the cyon was taken, but destitute of those qualities inherent in that fruit, and necessary to its keeping through the winter. This led me to call in question the propriety of grafting winter fruit on a summer stock, and to enquire, whether the stock through which, I supposed, the food passed to the cyon, and by which it was fitted properly to nourish the helpless and newly adopted branch, would not rather assimilate *that*, than that the cyon could, thus fed, retain all the qualities of its parent stock.

I am sensible that there are objections to this new system; and, perhaps, difficulties may be raised to it, which cannot be obviated.—But, as this may arise either from the erroneousness of the doctrine itself, or from the want of knowledge in the principles of vegetation, I think it should not be adopted or
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rejected without the fullest enquiry ; and especially, since a knowledge of the laws of vegetation is one of the most interesting matters which can be the subject of discussion : for on vegetation depends our being ; and in the same proportion as we obtain a knowledge thereof, and practise on that knowledge, in that proportion is our well-being promoted. That cultivation promotes vegetation, I think, none will deny : for surely the earth, spontaneously, gives us but a bare subsistence. The reasons assigned, why the earth did not more early bear fruit, were, because *there was no rain on the earth*, and because *there was no man to till the ground*.—The necessity of which seems to have produced one of the first decrees from heaven to man, even while he was in *Eden*, surrounded with all the blessings thereof, that he should dress the garden. Whether tilling and dressing the earth so prepares its parts that they became proper food for the plant, and thereby promote vegetation ;—whether, by tilling and dressing, the land is fitted properly to receive the rays of the sun, and to receive and retain a suitable quantity of water, with which food for the plant is supposed, by some, to fall ;—or whether, by tilling and dressing, the land does really partake of more particles necessary to vegetation, and so attracts like particles floating in the air, as similar bodies attract each other, and so light on, and feed the plant in their fall, or do rest on the earth, are absorbed by the roots, and thence conveyed thro' the whole plant, are questions which can, I think, be determined with more ease and greater certainty when the principles of vegetation are fully ascertained.

Please to favour me with the result of your enquiries on these matters, and it will much oblige him who has the honour to be, &c.

B. L I N C O L N.

Hon. Gen. Warren,

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THE idea has universally obtained, that *Trees grow from the root upwards*. But perhaps it may appear probable, from the following considerations, that *Trees, from the first year, grow from the top downwards*.

The growth of annual plants seems to be the mere expanding of the parts contained in the seed, or bulb, which is a more perfect and full grown seed, differing but little from what is commonly called seed. Of this, the bulb of a tulip is the best example, as the parts are visible without the help of glasses. Upon removing the several coats of the bulb, each of which are the support of a leaf, in the center of it, a large flower, near half an inch in length, will be found, and, in thickness, as large as a rye-straw; in which the petals, stile, filaments and buttons are fully formed, and perfect in every respect but size and colour. The lower leaf of the plant, which, within the bulb, covers all the rest, swells and expands first: then the next above swells and expands; and so on, until the whole are expanded: after which, the stalk rises, the flower swells and opens, and its beautiful colours are separated and exhibited to the eye. In this growth the bulb is entirely wasted, except only the fine skin that covered each squamina, which remains much thinner than white paper. In the center of the bulb, below the leaves and adhering to the stalk, may be seen a very small bulb, much less than the seeds of the plant. This bulb is, however, increased with the growth of the leaves, until it becomes of the size of the parent bulb: and when the stalk, the leaves and fibrous roots decay and dry up, this new bulb remains, in the place of the old one, capable of a like growth the next year.

The first year's growth of a tree, like that of plants, is the mere expansion of the parts contained within the seed, so far as those parts are fitted for growth ; and being expanded, the wood formed has no further growth, in any direction, but remains of the same size until it decays. Each leaf which grows on the first year's shoot, as well as those of succeeding years, has annexed to it, immediately above its stem, an embryo bud, which is nourished and fitted to grow the following year, and to become a branch of the future tree. The leaf having performed its maternal duty, falls to the ground, and manures the tree from whence it fell.

The wood of these saplings of a year, is uniformly of one texture ; but the wood of the next year is separated from it by a circular line, which remains as long as the wood lasts. Every succeeding year is distinguished in the same manner ; so that by cutting the tree on one side, from the circumference to the center, and counting those circles, you may ascertain its age.— And one of the main questions, arising in the consideration of this subject, is, how are these annual additional circles of wood formed ? Are they formed by the filling and expanding of fibres, which, too small for the observation of our senses, lie between the bark and the tree ? or are they new fibres shooting either from below or from above ? It appears, by examining the wounds of trees, that the wood being once separated never heals up and grows together.—The new wood grows over, and covers the wound ; but the separated vessels never unite again : therefore, if the edge of a knife be passed transversely thro' the bark half round a sapling, and those supposed extreme fine vessels were cut off, that side of the tree ought to cease growing, and the buds above it perish. But the fact is otherwise : for, cover
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the wound so as the air may be prevented from carrying off the moisture, which, when uncovered, flows from the wound, the buds above will grow nearly as well as if the wound was not made. To suppose that new vessels, formed at the root, ascend, and seeking the buds, by passing round the incision, immediately find them, is too ludicrous an objection to be seriously noticed. Let us, then, consider the buds which are formed in the bosom of every leaf.

One of those buds, rended from its parent plant, and inserted in the bark of another tree of the same genius, will grow as well as if it had been continued where nature placed it, and become a compleat tree. Here, at least, there is a certainty, that there are no fibres calculated to support it, yet it will grow ; and the whole tree, above the insertion in the stock, thus springing from a foster-bud, is exactly of the same nature in all respects, and produces the same fruit as the tree from which the bud was taken. This is the wonderful circumstance, which, though often attempted, has never been clearly accounted for. We shall proceed to enquire, then, how buds inserted in foreign stocks attain their growth.

When a bud is bro't into contact with the stock, and the bark of the stock passed round and upon the bark laid in with the bud, the sap very quickly forms a gum, which glues them together, and stops the mouths of those vessels which had been torn by separating the bark and bud from the parent tree. Whoever examines the fact, must be convinced, that the bud, thus laid in, never has any further adherence to the stock ; but remains, during the life of it, liable to be separated from it by dissolving that gum ; and, from this circumstance, the size and shape of the wood, or bark, laid in with the bud, may be plainly discovered

vered many years after its insertion. Here the communication between the stock and the bud is destroyed : for, if the sap penetrated this gum, it would dissolve it, and the bud would fall off ; and there can certainly no fibres be sent from the root to feed a bud, which nature had not placed there. Nothing but experiment could induce a belief, that a bud, thus situated, would grow, become a tree, blossom and bear fruit. Let us see how buds grow in the situation assigned them by nature.

The largeness of the bud, and the freedom with which it shoots, renders the peach-tree a proper subject of this enquiry. Early in the spring, when the bud first begins to swell, we shall find one or more fibres shooting from it downward. These fibres are so large, below the bud, as apparently to swell the bark, and on removing the bark the fibres may be plainly seen by the naked eye. Whoever carefully examines this fact, will scarcely doubt that this is really the manner in which buds begin to grow. Inoculations having the same power of sending out fibres from themselves as buds, in their natural situations, need no nourishment from the stock on which they are fixed ; but it becomes the question, from whence is their nourishment derived ?

A curious yellow carnation, presented to a gentleman at *Lancaster*, in the year 1778, being transplanted very early in the spring, and the weather proving very cold, he was obliged to take it into the house, and keep it in a room where fire was kept. Notwithstanding his utmost care in keeping the earth well watered, the plant declined, the leaves became soft, and rested on the earth, and the plant shewed every symptom of approaching death. In this state, having bended twigs over the pot, he wet a thick tow-cloth and threw over the plant, which

formed a moist atmosphere round it. In a few hours the leaves became erect, and elastic, and within three days the whole plant assumed the aspect of perfect health. The roots had a full supply of moisture, but it did not grow ; the leaves were supplied, and the plant instantly flourished.

The first appearance of vegetation among trees here, is the flowing of the sap in the sugar maple. This begins with the frosty mornings in the month of February. These hoar frosts never appear but when the air is moist ; and it is invariably certain that the sap ceases to flow when the wind is at north-west and the air dry, be the state of the earth as to moisture or frost as it may. From hence it appears, that the sap is extracted from the air even before the leaf is expanded, and not from the earth, as is generally supposed.

The next appearance of vegetation, is the swelling of the bud in the scarlet maple ; and in this, as in all other trees, it is to my purpose to observe, that the uppermost buds always swell first, and its beautiful blossoms are seen earliest to unfold on the topmost boughs. This cannot depend on a sap derived from the root ; for, in that case, the lowermost should have unfolded first.

The husbandmen of *New-Jersey*, upon those lands which do not produce oak-timber sufficient for fencing, shave the bark from the pine trees in the latter part of winter, and in the spring, the turpentine running down over that part of the tree which has been barked, fills the pores, and preserving it against the water, renders the pine a very durable post for fencing. The turpentine, as I conceive, being collected from the air, descends from the top of the tree. This practice, lately introduced, deserves attention, not only as an argument in this question, but

as an important lesson of instruction to those who live on pine lands.

The experiments made on fruit-trees, by extending their branches into green-houses while the roots remain in the ground, need not be repeated. They are better known than understood ; and can only be accounted for by supposing that their nourishment is derived from the air. Of this the following experiment may be a proof.

A branch of the maple being separated from the tree, and the lower end sealed, placed in any part of the tree, will bloom as soon as any of the adjoining branches not separated from the tree will do. The buds of trees, deriving their nourishment from the air, send down their fibres between the bark of the tree and the former year's growth of wood, and lay an additional wood over the former growth. It is upon this principle alone, that the growth of inoculations can be accounted for ; and it is clear and plain, that every bud has its own pith, perfectly distinct from the tree it is attached to, and has also in itself every other part of a tree.

From a due consideration of what has been said, it will appear, that the growth of annual plants is the expanding of the parts contained within their seeds as bulbs, and a production of other seeds and bulbs, perfectly distinct and unconnected with the former ; but that the growth of trees after the first year is the expanding of buds, adhering to the former growth, and the fitting of other buds for future growth attached to the tree, as well as forming of seeds, as annual plants do.

